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ABSTRACT

The supplantation approach of this study hypothesized that media attributes may serve to bridge the processing link between learner aptitude capacity and the demands of a concept attainment task. Subjects were 492 males aged 16-21, drawn from a College of Technical and Further Education in Melbourne, Australia. All subjects were trade apprentices, predominantly from the automotive department. Classification of five types of diesel fuel injectors was used as the concept attainment task. The study utilized a treatment-by-blocks design. The aptitude block was composed of two levels: extreme field-independent individuals and extreme field-dependent individuals. Three treatment variables combined to form eight treatments. Each treatment contained either color or non-color cueing, plus simple or complex line-drawings on filmstrips accompanied by either an inductive or a deductive verbal presentation on audiotape. Two immediate posttest measures were used: an identification line-drawing test and an identification-transfer test (realia test) that used real fuel injectors. Analysis of variance revealed interactions which suggested that treatments were differentially effective in meeting the differing task requirements of a transfer and a non-transfer posttest measure. (Author/LMM)

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**Aptitude Sensitive Instruction: The Role of
Media Attributes in Optimizing Transfer of Training**

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ABSTRACT

The supplantation approach of this study hypothesized that media attributes may serve to bridge the processing link between learner aptitude capacity and the demands of a concept attainment task. The study utilized a treatment-by-blocks design. The aptitude block was composed of two levels: extreme field-independent individuals and extreme field-dependent individuals. Three treatment variables combined to form eight treatments. Each treatment contained either color - or non-color - cueing, plus simple or complex line-drawings accompanied by either an inductive or a deductive verbal presentation. These treatments were selected according to their proposed supplantation value to increase the salience of relevant concept attributes. Analyses of variance revealed interactions which suggested that treatments were differentially effective in meeting the differing task requirements of a transfer and a non-transfer posttest measure. Findings may be of interest to those in instructional/training settings in which learners are required to transfer learning from a technical line-drawing presentation to a real object.

APTITUDE SENSITIVE INSTRUCTION:
THE ROLE OF MEDIA ATTRIBUTES IN OPTIMIZING
TRANSFER OF TRAINING

The power of media to influence our values, opinions and actions confronts us whenever we turn on the television or open a magazine. Many training/educational materials aim to utilize this power for instructional advantage. The study to be described in this paper argues that sound instructional use of media must be based upon consideration of the impact that specific combinations of media attributes have on the internal psychological/cognitive processing operations of learners.

RATIONALE AND PURPOSE

The Role of Media Attributes

The aim of the present study was to investigate treatment variables which may interact to facilitate perception and learning of a concept. In many areas of training and technical education, students are frequently required to utilize line-drawings in learning situations. Because much instruction is primarily conceptual in nature, instructional designers often express interest in how best to design technical line-drawings for effective use with other media in instructional modules which teach concepts.

A frequent decision facing the instructional designer is the selection of a way to present the instructional message most effectively for all learners. This problem of media choice has raised continuing concern among media researchers, instructional designers and classroom teachers. Educational philosophy today places emphasis upon both the need to consider alternative means of providing instruction, and the need to choose from media alternatives on the basis of criteria which will maximize effective learning (cf. Cronbach & Snow, 1977; Salomon, 1979). This raises the need for sound criteria upon which to base selection of media. Jackson and Kieslar (1977) have observed that most practitioners prefer to rely upon experiences and intuition, rather than to turn to researchers for advice. This observation is not surprising in the light of growing criticism of educational/instructional media research findings. Many authors have commented upon a disappointing lack of practical, definitive research findings to guide media selection (Allen, 1971; Heidt, 1975; Olson, 1974; Salomon and Clark, 1977). Several writers have noted that hundreds of studies to date have compared the effect of one medium with the effect of another medium without carefully defining what is being compared (Chute, 1979; Clark, 1975; Levie and Dickie, 1973; Salomon and Clark, 1977; Schramm, 1977). The use of these macro-media comparisons has been

termed "research with media" (Salomon and Clark, 1977, p. 102). The realization that gross media comparisons have contributed little to educational practice has been accompanied by appeals for more theoretical conceptualization to focus researchers' attention upon more valid questions dealing with more specific qualities of media (Levie and Dickie, 1973; Salomon and Snow, 1968; Salomon and Clark, 1974, 1977). These authors have suggested that a more productive conceptualization of research would be one that specifies relevant media variables in terms of the attributes of media rather than media as modes of stimulus presentation. Salomon and Clark referred to this different research focus as "research on media" (1977, p. 102). It has been suggested that attributes of media may be defined in terms of their psychological effects and instructional effectiveness, rather than in terms of their physical appearance (Heidt, 1977; Levie and Dickie, 1973; Salomon and Clark, 1977; Salomon, 1979). This view places emphasis upon a learner's mode of internal processing of information. Salomon (1979) has noted that learning will be most effective when media and the teaching process are precisely adjusted to the processes the learner has to carry out. He noted that different learners often respond to the same information in quite different ways, and advocated that the presentation of information must be precisely adjusted to a learner's own internal symbolic representations. Salomon and Clark (1977) suggested that future media research should seek to find which physically different attributes of media or technology have a high probability of eliciting common responses in learners of similar aptitudes. They suggested that these attributes could then be treated conceptually as equivalents. This approach is linked closely to the theory of Aptitude Treatment Interaction (ATI) research, which has also called for more specification of experimental variables (Cronbach and Snow, 1977). The ATI approach seeks to study the nature of a medium's most relevant attributes as they relate to the psychological functions they can accomplish for different learners under specified task conditions. Both Cronbach (1975) and Salomon (1979) have called for research that is theoretically based to develop explanatory principles that may function as "skeleton hypotheses" (Salomon, 1979, p. 12) to which numerous practical instances could apply.

Thus, a new set of research assumptions may be applied to the role of media in instruction. The most important difference to those of past research with media is that research on media should specify relevant variables in terms of attributes of media which relate to learners' psychological responses. Media attributes may be defined first as properties of stimulus materials that are inherent in the physical dimensions of media.

The attributes of a medium then, are the capabilities of that medium -- to show objects in motion, objects in color, objects in three dimensions; to provide printed words, simultaneous visual and auditory stimuli; to allow for overt learner responses or random access to information. (Levie and Dickie, 1973, p. 860)

THEORY INTO PRACTICE

The present study sought to combine media attributes according to an Aptitude Sensitive Instruction research model. This model is based upon the supplantation approach (cf. Ausburn and Ausburn, 1977; French, 1982; and Salomon, 1979). The supplantation approach of this study hypothesized that specific combinations of media attributes may serve to bridge the processing link between learner aptitude capacity and the processing demands of the concept-attainment task. Treatments were selected according to their hypothesized supplantation value on the basis of: 1) Analysis of processes reflected by field-dependent/independent cognitive style, and 2) extensive task analysis.

The Effect of Cognitive Style on Concept Attainment

In a typical visual concept-attainment task, learners are required to distinguish examples from non-examples of each concept class. To complete this task successfully, a learner needs the aptitude capacity: 1) to discriminate small visual details which characterize each concept example, and 2) to structure this information as generalizable rules which may be utilized to classify examples as members of a concept class (Gagne, 1977). In concept attainment tasks, learners appear to differ in their ability to discriminate a visual into its component details. Furthermore, learners also differ in the strategies they use to structure and generalize information as concepts. The cognitive style "field-dependence-independence" has been related empirically to these differences (Witkin, Moore, Goodenough, and Cox, 1977). Research findings have indicated that typical concept-attainment tasks are often more demanding for field-dependent individuals (Dicksteir, 1968; Kirschenbaum, 1968; Witkin, Moore, Goodenough and Cox, 1977).

The current view of field-dependence-independence is still evolving. During recent years, research has resulted in a complex description of the dimension which includes an ever-broadening pattern of an individual's psychological, intellectual and neurophysiological functioning. This pattern has been explained by what has been termed psychological differentiation theory (Witkin, Goodenough and Oltman, 1977). Differentiation theory attempts to account for the network of functions and behaviors that are responsible for an individual's self-consistency in approaching a variety of tasks and situations. Individuals who are more differentiated are implied to be more capable of carrying out specific functions in a specialized fashion. Goodenough and Witkin (1977) have hypothesized that a person's tendency to function in a more differentiated or less differentiated way is likely to characterize that individual's activities across psychological, intellectual and neurophysiological domains, thus contributing to self-consistency in individual functioning.

Individuals who are perceptually field-dependent have been found to experience their world in a less differentiated fashion when dealing with perceptual/cognitive tasks (Witkin, Goodenough & Oltman, 1977; Wilkin & Goodenough, 1977). The field-dependent learner tends to rely on external referents which influence the strategies used in concept attainment tasks. That is, field-dependent persons tend to accept the visual field passively, as presented, and to ignore important details which presumably are not salient to them. Furthermore, they appear to be dominated by the most salient or noticeable parts of a visual (Dickstein, 1968; Kirschenbaum, 1968). Hence, field-dependent individuals may be handicapped by unstructured materials in which relevant details are not made salient (Goodenough, 1976; Witkin, Moore, Goodenough & Cox, 1977). Their tendency to display less differentiated functioning is also evident in the processing strategies they use when directed to form concept hypotheses. Their hypothesis-testing strategy has been associated with a partist approach (Goodenough, 1976; Kirschenbaum, 1968). Field-dependent learners tend to form one concept hypothesis at a time, based on the most noticeable or salient features of the concept example. If subsequent examples reveal that the hypothesis is not valid, then new features are chosen, and a new hypothesis is formed. If subsequent examples substantiate these features, then the hypothesis is retained (Goodenough, 1976). In other words, the field-dependent learner acts as a passive spectator who tends to note the dominant, salient cues, until it becomes obvious that certain features are associated with positive examples of the concept (Witkin, Moore, Goodenough & Cox, 1977).

This strategy may be contrasted with the active, participant role of the field-independent learner. These learners are capable of more differentiated functioning. That is, they are capable of using their restructuring skills as internal mediational processes (Witkin, Moore, Goodenough & Cox, 1977). Their hypothesis-testing strategies have been associated with a wholist approach (Goodenough, 1976; Kirschenbaum, 1968). The field-independent learner tends to scan the first positive concept example, and to retain all its attributes for later comparison with those in subsequent examples. If the hypothesis is proven to be inappropriate, then a revised hypothesis is formed. The wholist strategy of hypothesis testing is more active than the partist approach, and has resulted in better learning performance particularly when subjects were under time pressure (Bruner, Goodnow & Austin, 1956; Bourne, 1966).

In his discussion of hypothesis-testing strategies, Mayer (1977) pointed out that the superiority of the wholist strategy could be due to its reduced demands on memory. The wholist has only to remember the attributes of the first example. Subsequent checks against examples reduce the memory requirement because the wholist is able to eliminate those attributes which fail to reappear. Conversely, the memory demands for the partist strategy will increase with each incorrect hypothesis. Subsequent new hypotheses will need to incorporate a record of all prior hypotheses that were disproven, to avoid using them twice.

In summary, it is important to note that both approaches can lead to successful concept attainment (Nebelkopf and Dreyer, 1973). However, field-dependent learners do have more difficulty than field-independent learners with discrimination tasks. That is, they have less ability to break down a visual into its component details. In concept learning tasks in which relevant details are not made obvious, the field-dependent learner may be at a disadvantage (Witkin, Moore, Goodenough and Cox, 1977). Furthermore, field-dependent and field-independent learners do differ in the methods they use to generalize information into concepts. Thus, when material to be learned is not clearly structured and organized, the field-dependent learners may experience learning difficulties (Witkin, Moore, Goodenough and Cox, 1977). Their difficulty may be particularly apparent when instructional time is limited by a fixed-pace presentation (cf. Bruner et. al., 1956, Bourne, 1966).

The relationship between field-dependence-independence and concept attainment is of particular concern to educators because of their interest in having students learn concepts, rather than facts alone. It is therefore natural to ask how field-dependent students may be aided ... (Witkin, Moore, Goodenough and Cox, 1977, p. 26).

The Effect of Media Attributes

French (1982) has developed an Aptitude Sensitive Instruction Research model to help the educator in deciding the best method to meet the different processing needs of learners (See Figure 1). The Aptitude Sensitive Approach asserts that learning will be most effective when the requirements of the learning task together with media attributes, either precisely complement the internal processing skills of the learner, or adapt to the aptitude of the student (French, 1982).

This approach places an emphasis upon learners' modes of internal processing of information. To those interested in the development of instructional materials, this means that it is as important to consider what students ought to do while they are learning, as it is to consider the validity of the content. This consideration was also apparent in the early work of Salomon (1970, 1972) when he added a new component to the conventional stimulus-response model and changed it to a three-stage S-r-R model. The new component, "r," signified the internal operations of information processing, which are released by the stimulus, "S," and lead to the overt behavior, "R." Salomon's initial hypothesis about the relations between media and the learner can be stated as follows: a) Different attributes of media affect or stimulate different internal operations of the learner; b) Different learners often respond to the same information in quite different ways: apparently they perceive the same stimulus in various ways and encode and process it in different manners; c) Learning will be most effective when the teaching process is precisely adjusted to the processes the learner has to carry out.

Ausburn & Ausburn (1977) and French (1982) advocate the use of media attributes as a "connecting link" which would otherwise be incomplete due to a learner's inability to meet certain task demands. Both Ausburn & Ausburn (1977) and French (1982) view this media link as a connection between learner and task that is facilitated through the use of supplantation techniques which form a bridging mechanism (See Figure 1).

The present study sought to utilize media attributes according to an aptitude sensitive approach which was aimed to increase the effectiveness of instructional materials for all subjects. Specifically, the study aimed to use a compensatory supplantation approach to facilitate concept attainment for field-dependent learners by "short circuiting" processing demands (cf. Salomon, 1979). See Figure 1. The "short circuiting" method provides ready-made transformations which may save the field-dependent learner from having to perform the required processing operations. The study also aimed to use media attributes to activate appropriate processing strategies for field-independent learners.

The present study incorporated the use of several media attributes which varied both in the nature and the amount of supplantation provided. These attributes represent the three independent treatment variables which were selected according to the hypothesized functions they may perform for learners differing in aptitude. The three treatment variables were varied systematically to determine their influence upon both field-dependent and field-independent learners' performance on a concept attainment task. The three treatments were:

- a) color versus non-color type of cueing;
- b) simple versus complex degree of informative detail;
- c) inductive versus deductive type of verbal presentation.

The first treatment variable of interest was that of the use of color-cueing of relevant visual details. In color-cued treatments, the relevant features (attributes) of each concept class were colored in red. Both Hull (1920) and Trabasso (1963) have used red to emphasize relevant attributes as an effective aid to concept-attainment. On the basis of discussions (e.g. Allen, 1975; Chute, 1979; Garrick, 1978) relating to the potential functions of color in instructional variable, several considerations led to the inclusion of color-cueing. These included the hypothesized ability of color:

- a) to direct attention to relevant details by making cues more salient and by delineating figure-ground relationships;
- b) to isolate details while maintaining context relationships as an aid in making discriminations;
- c) to provide organizational aids by showing interrelatedness.

It was hypothesized that these functions may facilitate concept attainment by increasing the salience of relevant concept attributes. However, color appears to be a "fragile cue ... apt to be superceded by more potent cues" (Otto & Askov, 1968, p. 163). Both Otto & Askov and Chute (1979) have suggested that instructional materials should not have color as the only cue available to facilitate processing, especially in complex tasks that are high in stimulus similarity. This should not be interpreted to suggest that color is an ineffective cue. When used to perform an integral function (cf. Chute, 1979), color can be more effective, especially when the relevant concept attribute is embedded (Trabasso, 1963). Both Chute (1979) and Lamberski & Roberts (1979) have suggested that the value of color may lie in its possible interrelated role.

Trabasso (1963) revealed that the effect of color emphasizeers may be reduced by counter-emphasizers; that is, irrelevant information which was not held constant appeared to compete for the subject's attention by directing the learner away from relevant details. Many relevant-cue theorists (e.g., Canelos, 1979; Dwyer, 1972) propose that in some learning tasks, complexity should be edited or simplified in order to avoid processing interference caused by too many relevant cues. To test these views, the present study included both simple line-drawing and complex line-drawing treatments as a second independent, treatment variable. This variable was termed degree of informative detail, in order to reinforce that degree of abstraction/realism was not used to differentiate simple from complex line-drawings.

In complex treatments, the line-drawings were high in informative detail; that is, they showed a high degree of interior (figure) and ground detail that was not related to the concept. Simple line-drawings were lower in degree of informative detail; that is, they showed mainly relevant interior (figure) detail and as little irrelevant detail as possible. Several functional considerations led to the inclusion of simple degree of informative detail in the study. These included the hypothesized ability of simple line-drawings:

- a) to isolate details while maintaining context relationships (cf. Heidt, 1977);
- b) to reduce the counter-emphasizer effect of irrelevant stimuli (cf. Trabasso, 1963);
- c) to decrease abstraction time and learner effort (cf. Canelos, 1979; Fleming & Sheikhan, 1972; and Joseph, 1979);
- d) to facilitate objectives requiring the comprehension and explanation of concepts (cf. Arnold & Dwyer, 1975).

In cue-summation theory, Severin (1967) raised the question of the possible summation of cues between auditory and visual channels. The present study was also concerned with the possible summation of an emphasis effect by presenting information through more than one sense modality. Hence, the third treatment variable related to the auditory mode. This variable was termed inductive versus deductive mode of verbal presentation.

Both inductive and deductive treatments were presented via an audiotape which accompanied the line-drawings. Deductive presentations utilized a specific verbal description of the features of each concept type. The deductive presentation was made immediately before the visual presentation of examples and nonexamples. The deductive mode of presentation may be contrasted with the inductive mode which did not provide a verbal description of each concept type. Instead, the inductive presentation urged the subjects to search for the defining attributes of each concept type. The provision of a concept definition in addition to a set of teaching examples has been found to be significantly more facilitative than a set of teaching examples alone (Feldman, 1972). Pishkin (1965) has suggested that specification of concept attributes may reduce learning difficulty by reducing the number of hypotheses to be considered. Ausubel & Robinson (1969) have suggested that for learners to learn effectively, they should be presented with background information as a basis for understanding new facts. This "advance organizer" approach may closely parallel the deductive presentation used in the present study. Several studies have supported the use of descriptions which provide verbal cues to concept definition (e.g., Frayer, 1970; Frederick, 1972; Pishkin, 1965). Based on the preceding research findings, several functional considerations led to the inclusion of deductive mode of presentation in the present study. These included the hypothesized ability of deductive presentations:

- a) to direct attention to relevant details through the use of verbal cues and by increasing redundancy of critical information;
- b) to provide organizational aids through advance verbal description of relevant details.

METHODOLOGY

The study utilized a treatments-by-blocks design (cf. Keppel, 1982). The aptitude block was composed of two levels: extreme field-independent individuals and extreme field-dependent individuals. Aptitude blocks were designated on the basis of performance on the Group Embedded Figures Test (Witkin, Oltman, Raskin and Karp, 1971). Field-independent subjects were determined to represent the upper 27-1/2% of highest scoring subjects. Field-dependent subjects were determined to represent the lower 27-1/2% of lowest scoring subjects (cf. Feldt, 1961).

The subject sample of 492 males aged 16-21 years, was drawn from a College of Technical and Further Education in Melbourne, Australia. All subjects were trade apprentices predominantly from the automotive department. As subjects were trade apprentices, the classification of five types of diesel fuel injectors was determined to be an appropriate concept attainment task. Five types of injectors were selected to represent five different concept classes. Most of the injectors had global similarities, yet, each concept class had specific differences which allowed for the classification of each example into one of the five concept groups.

The instructional materials consisted of a series of line-drawings which were copied onto filmstrips with an accompanying audiotape. Subjects were pretested for existing knowledge, and then randomly assigned to an individual soundfilmstrip machine which was loaded with one of the treatment combinations. Each treatment was externally-paced. The three treatment variables combined to form eight treatments, each of which contained either color or non-color cueing, plus either simple or complex line-drawings accompanied by an inductive or deductive verbal presentation. By administering these eight treatment combinations to each of the aptitude blocks a total of sixteen treatment groups were formed. Thus, a $2 \times 2 \times 2 \times 2$ factorial, extreme-groups design was used to implement this study. Six dependent variables were measured for all subjects. For this discussion, the results of two immediate posttest measures will be outlined and compared.

- a) An identification test. (This test is referred to as the line-drawing test.) Following the completion of all instructional sequences, the subjects were presented with a series of 21 line-drawings. Subjects were also given an answer sheet numbered from 1 to 21, with the names of each of the five injector types repeated for each item. The test required that each subject view each line-drawing, and then identify the injector type by circling the appropriate name for the corresponding item on the numbered answer sheet. The choice of 21 line-drawings was based on a concept analysis conducted by the researcher, prior to the experiment.

The ability to identify different examples as belonging to the same concept class appears to relate most specifically to the classificatory level of Klausmeier, Ghatala & Frayer's model of conceptual learning (1974). At the classificatory level, the learner not only can discriminate and recognize concept attributes, but also can generalize to other examples on the basis of specific, common attributes. It is important to note that learners who performed well on the line-drawing test may have reached the formal level of Klausmeier's model. At the formal level the learner can identify examples and nonexamples of the concept, and most importantly can name the concept and accurately identify it in terms of all its relevant attributes.

- b) An identification - transfer test (called the realia test). Following completion of all instructional sequences, the subjects were presented with a series of "real fuel injectors" for identification. The test required that each subject view and handle each injector, and then identify it by circling the appropriate name on a numbered answer sheet. This test is similar to the preceding identification, line-drawing test in that it also related to Klausmeier, Ghatala and Frayer's classificatory and perhaps formal levels of concept learning (1974). However, in the realia (identification-transfer) test, the learner was required to transfer learning from the two-dimensional, line-drawn representations of fuel injectors to actual three-dimensional realia. The realia posttest was included as a practical "real world" measure of student achievement. Selection of the seven items for the identification-transfer (realia) test was based on detailed concept analysis.

DATA ANALYSIS

A four-way analysis of variance was used to investigate main effects and interactions among the four factors; that is, the three treatment variables and the subject aptitude variable. Where a significant three-way interaction occurred, the interpretation of the nature of the interaction was facilitated through a series of analyses of simple effects. These analyses sought to identify the source or locus of the interaction using procedures and formulae given by Keppel (1973, 1982) and Kirk (1968).

It should be noted that there was some subject mortality after subject allocation to treatments resulting in unequal n's in the treatment of groups. These subject losses were caused by equipment breakdown and administrative procedures. Mortality was not related to the experimental treatments. Analyses of designs with unequal sample sizes may warrant consideration of the possible violation of the homogeneity of variance assumption (Keppel, 1982; Kirk, 1968). Hence, in the present study, this assumption was tested using the Hartley Test using procedures given by Kirk, 1968. Results indicated that the homogeneity assumption was not violated (see Table 1). This permitted the use of standard F tables in the analysis of data from this study.

RESULTS

The Pretest

Analyses of scores for the pretest of prior knowledge revealed that there was no significant difference between the pretest scores of the field-independent and field-dependent groups, $t(247) = 1.08$, $p > .1$.

The Posttests

This paper will focus upon a comparison of three-way interactions revealed by the posttest measures.

The Line-Drawings Posttest

Analysis of variance revealed statistically significant findings for the line-drawings test. As interactions were found, the main effects of the factors involved in the interaction must be interpreted with caution (cf. Keppel, 1982). The analysis of variance and inspection of treatment means suggested the following main effects: (a) Degree of informative detail -- students in simple line-drawing treatments scored significantly higher than students in complex line-drawing treatments, $F(1,229) = 10.45$, $p < .01$; (b) Mode of verbal presentation -- the deductive-treatments resulted in significantly higher scores than the inductive treatments, $F(1,229) = 11.95$, $p < .001$; (c) Subject Aptitude -- field-independent subjects scored significantly higher than field-dependent subjects on the line-drawing (identification) test, $F(1,229) = 60.36$, $p < .0001$.

The analysis of line-drawing scores also revealed two statistically significant interactions. Simple/complex treatment (degree of informative detail) interacted with field-dependence-independence (subject aptitude), $F(1,229) = 6.31$, $p < .05$. The color/non-color cueing by simple/complex drawings by inductive/deductive treatments interaction; (that is, type of color cueing $\times$ degree of informative detail $\times$ mode of verbal presentation) also was significant, $F(1,229) = 5.30$, $p < .05$. Table 2 provides a summary of the analysis of variance.

The presence of significant interactions in the analysis of variance renders the main effects uninterpretable without further analyses of the nature of the interactions. These tests were conducted and led to the following results. Figure 2 graphically presents the means of the significant three-way interaction. It is important to note that the influence of color/non-color cueing appears to be significant in this higher-order interaction. This led to a test of the simple interaction effect of the simple/complex variable with the inductive/deductive variable for each of the color and non-color treatment groups. The results of these F tests indicate that the interaction effects were not significant in color-cued treatment, but were significant in non-color-cued treatments, $F(1,229) = 4.87$, $p < .05$. A summary of the results of the tests of simple interaction effects may be found in Table 3.

Subsequent analyses of simple, simple main effects of the three-way interaction revealed that there was no significant difference between deductively presented, simple, non-color-cued treatments and inductively presented, simple, non-color-cued treatments. However, deductively presented, complex, non-color-cued treatments scored significantly higher than inductively presented, complex, non-color treatments; $F(1,229) = 10.84, p < .001$. See Figure 2 (right panel), and Table 4. This pattern of results was not evidenced in color-cued treatments. Analyses of simple, simple main effects revealed that in treatments that were color-cued, there was no significant differences between deductively presented, complex treatments and inductively presented, complex treatments. However, deductively presented, simple, color-cued treatments were superior to inductively presented, simple, color-cued treatments; $F(1,229) = 6.95, p < .01$. See Figure 2 (left panel) and Table 4.

A second set of simple, simple main effects focused on simple/complex degree of informative detail. These analyses revealed that simple, inductive, non-color treatments scored higher than complex, inductive, non-color treatments; $F(1,229) = 9.76, p < .01$. There was no significant difference between simple, deductive, non-color treatments and complex, deductive, non-color treatments. See Figure 2 (right panel) and Table 4. This pattern of results was not evidenced in color-cued treatments. Analyses revealed that in treatments that were color-cued, there was a significant difference between simple, deductive treatments and complex, deductive treatments; $F(1,229) = 4.09, p < .05$. However, there was no significant difference between simple, inductive, color-cued treatments and complex, inductive, color-cued treatments. See Figure 2 (left panel) and Table 4.

All treatment group means and standard deviations for the line-drawings posttest have been presented in Tables 5 and 6. The line-drawings posttest reliability coefficient was $r_{tt} = .72$.

The Realia Posttest

Analysis of variance of the realia posttest revealed one statistically significant main effect, and one statistically significant three-way interaction. It is important to note that the main effects of the factors involved in the interaction were not significant in the overall analysis. Hence, the F test involving the significant main effect may be interpreted without qualification. The analysis of variance and inspection of treatment means revealed the following main effect: (a) Subject Aptitude--field-independent subjects produced significantly higher realia posttest scores than field-dependent subjects, $F(1,231) = 7.35, p < .01$.

The analysis of realia posttest scores also revealed a significant three-way interaction. All treatment variables contributed to this interaction; that is, type of color cueing X degree of informative detail x mode of verbal presentation, $F(1,231) = 6.44, p < .025$. Table 7 provides a summary of the analysis of scores on the realia posttest items.

Further analyses were conducted to determine the nature of the three-way interaction. Figure 3 graphically presents the means of this higher order interaction of the three treatment variables.

Tests of the simple interaction effects of the three-way interaction were conducted to determine the nature of the variation due to the interaction of two of the independent variables, B and C, at each of the two levels of the third variable, factor A. This interaction, shown in Figure 3, represented a meaningful way for this researcher to view the three-way interaction. That is, the interaction of factor B, the simple/complex (degree of informative detail variable with factor C, the inductive/deductive (mode of verbal presentation) variable was analyzed within each of the levels of factor A (color-cued/non-color-cued treatments). The results of the F tests of simple interaction effects revealed that the interaction effect was not significant in color-cued treatments ($B \times C$ at a_1), but was significant in non-color-cued treatments ($B \times C$ at a_2), $F(1,231) = 8.62$, $p < .01$. In other words, the tests of simple interaction effects indicated that the interaction of simple/complex treatments with inductive/deductive treatments was not significant for color-cued materials, but was significant in non-color-cued treatments. A summary of the results of the tests of simple interaction effects may be found in Table 9.

The significance of the $B \times C$ interaction for non-color-cued materials (a_2) suggested further analysis. Subsequent analyses consisted of testing the variation among the cells of a given row or column of the non-color matrix; that is, testing simple, simple main effects of factors within the non-color matrix. The first set of tests of simple, simple main effects focused on factor B (simple/complex--degree of informative detail). These tests sought to determine the influence of factor B at levels a_2c_1 (non-color, inductive), and a_2c_2 (non-color-deductive). The results of these tests of simple, simple main effects may be interpreted with reference to the right panel of Figure 3. The test of B at a_2c_1 revealed that simple, non-color, inductive treatments scored significantly higher than complex, non-color, inductive treatments, $F(1,231) = 8.04$, $p < .01$ (see Figure 3 and Table 9). However, the results of the test of simple, simple main effects indicated that there was no significant difference between simple, non-color, deductive treatments and complex, non-color, deductive treatments.

A second set of tests of simple, simple main effects focused on factor C (inductive/deductive -- mode of verbal presentation). These tests sought to determine the influence of factor C at levels a_2b_1 (non-color, simple), and a_2b_2 (non-color, complex). Results of these tests of simple, simple main effects may be interpreted with reference to the right panel of Figure 3. The test of C at a_2b_1 revealed a significant difference, $F(1,231) = 12.30$, $p < .001$ (see Table 9). Inspection of the appropriate means in Figure 3 shows that inductive, non-color, simple treatments were superior to deductive, non-color, simple treatments in this test of C at a_2b_1 . There was no significant difference between inductive, non-color, complex treatments and deductive, non-color, complex treatments in the test of C at a_2b_2 (see Table 9, and Figure 3).

Tests of simple, simple main effects were extended to determine the influence of both factor B and factor C among the cells of a given row or column of the color-cued matrix. The results of these tests of simple, simple main effects may be interpreted with reference to the left panel of Figure 3. The tests of B at a₁c₁ and B at a₁c₂ were not significant (see Table 9). The tests of C at a₁b₁ and C at a₁b₂ were also not significant (see Table 9, and Figure 3).

All treatment group means and standard deviations for the realia posttest have been presented on Tables 10 and 11. The realia posttest reliability coefficient was $r_{tt} = .42$.

DISCUSSION

The success of attempts to improve the general effectiveness of instructional materials for all subjects was evident in the significant findings reported for both interactions and treatment main effects for both posttests. Some treatment combinations were more effective than others for all subjects. Theoretically, this may suggest that it is possible to utilize instructional materials which not only allow high-aptitude (field-independent) learners to activate successful processing strategies, but also provide compensatory supplantation for the reduced capacity of low-aptitude (field-dependent) learners. The need to provide such supplantation may be most apparent when learners are constrained by the time demands of an externally-paced presentation in a concept attainment task in which concept attributes are not salient. The general effectiveness of some treatment combinations for all subjects should not be interpreted as suggesting that prescription of instructional media should be made without consideration of aptitude factors. The same treatment may serve different processing functions for high and low aptitude groups. These results suggest that instructional prescription needs to be sensitive to the specific processing needs of the specific learners for whom materials need to be produced. Results from both measures confirmed that learners with field-dependent aptitude have difficulty with externally paced, concept attainment tasks which require the ability to discriminate and to generalize.

In general, there was no significant difference between color-cued and non-color-cued materials in both posttests. However, analyses of the three-way interactions of all treatment variables revealed that the pattern of results in the color-cued treatments differed to the pattern of results in the non-color-cued treatments for both posttests. These results may support the conclusions of Chute (1979) and Lamberski & Roberts (1979) who have suggested that the significance of the color variable may be in its possible interrelated role.

Analyses of simple, simple main effects (realia posttest) revealed that the effectiveness of treatments that were not color-cued was greatly facilitated when simple, inductive presentations were used. That is, non-color-cued, simple, inductive treatments scored higher than non-color-cued, simple, deductive treatments, and non-color-cued, complex, inductive treatments. There was no significant difference between any of the treatments that were color-cued (realia posttest). It is important to note that these patterns of results for the three-way interaction (realia posttest) are quite different to those reflected by the three-way interaction of the same factors on the line-drawings posttest. (See Figures 2 and 3.)

Performance in non-color-cued treatments was not facilitated by simple, deductive presentation or complex, deductive presentations as it was on the line-drawings posttest. The superiority of simple, deductive presentations in color-cued treatments, evident in the line-drawings posttest, was not revealed in the realia posttest. Furthermore, simple, inductive, non-color treatments were superior to all other non-color-cued treatments on the realia posttest.

The apparent superiority of simple, inductive presentations in non-color-cued treatments may be related to the unique processing demands of the realia posttest. This posttest required that learners demonstrate concept attainment by correctly identifying realia which belonged to the same concept class. The realia (identification) posttest differed from the line-drawings (identification) posttest in that the realia measure required that learners transfer their knowledge to identify actual examples of the concept. The processes required to transfer learning in order to classify actual concept examples appear to have been aided by non-color-cued, simple, inductive presentations. In other words, non-color, inductive presentations may have freed learners to utilize their cognitive restructuring skills and hypothesis testing strategies when simplified visuals were used. The inductive treatments may have facilitated transfer by actively involving each learner in processing concept information when used in conjunction with the other two variables. The simple line-drawings may have contributed the interactive effect by: (a) directing attention through removing irrelevant details and thus reducing their counteremphasizer effect; (b) directing attention to relevant cues and thus delineating figure-ground relationships; (c) isolating relevant concept attributes; and (d) decreasing abstraction time and effort. The functional attributes of simplified visuals may have been of critical importance for low-aptitude learners. These field-dependent learners may have had difficulty in successfully completing the task when non-color, inductive presentations (low in salient cues) were used. This difficulty may have been accentuated without the addition of simplified visuals to isolate relevant details and to direct attention.

Previous research findings provide partial support for the findings on the realia posttest. For transfer tasks, inductive/discovery approaches have been found to result in superior performance (Wittrock, 1966; Travers, 1977). As Travers (1977) pointed out the advantage of discovery-learning would seem intuitively to be based on the importance of encouraging learners to be more actively involved in their own learning.

Although the three-way interaction of all treatment variables accounted for only 1.3% and 2.2% of the total variance for the line-drawing test and the realia test respectively, the theoretical implications of these findings may be of significant interest to those involved in the research and design of instructional materials.

IMPLICATIONS

From the findings of this study the following skeleton hypotheses have been proposed as guides for future research and practice relating to aptitude sensitive instruction and the role of attributes in optimizing transfer of training. The findings of this study are based upon the view that attributes of a mediated stimulus may interact with task demands and learner aptitude to enable the presented information to be processed more efficiently and effectively by learners of differing cognitive styles.

1. In general, field-dependent performance on an externally-paced, concept-attainment task may fail to reach an acceptable criterion (for both identification/line-drawing and transfer/realia posttests) unless materials provide supplantation by increasing the salience of relevant cues and by providing organizational aids. For example, simple, deductive, color line-drawings may have provided supplantation for field-dependent learners (on the line-drawings posttest). These treatments may have functioned to compensate for processing weaknesses by directing attention and by increasing the salience of critical concept cues. This may have produced an organizational aid to reduce abstraction time and effort for field-dependent learners.
2. In general, field-independent performance on an externally paced, concept-attainment task may reach an acceptable criterion (for both identification/line-drawing and transfer/realia posttests) even when materials lack organization and salient, relevant cues. Nevertheless, performance may be facilitated through the use of media attributes which increase the salience of relevant cues and provide organizational aids. For example, although field-independent learners reached an acceptable criterion for all treatments -- simple, deductive, color presentation may have provided most appropriate supplantation for field-independent learners (on the line-drawing posttest). Simple, deductive, color treatments may have functioned to actuate appropriate processing strengths, thus reducing abstraction time and effort.
3. Materials designed to teach a concept may be most effective when media attributes are selected with sensitivity for specific processing demands of the task as they relate to the cognitive styles of the learners. For example, in this study the processing strategies of both subject groups were constrained by an externally-paced presentation. Simple, deductive, color treatments were facilitated for both subject groups (on the line-drawing posttest). While this treatment facilitated ease of processing for field-independent individuals, it may have been of critical importance for field-dependent learners. Difficulty for these learners may have been accentuated by presentations which demanded ability to isolate relevant details and to organize information into concept classes. Improved

field-dependent performance in simple, deductive, color treatments may be attributed to their supplantation value in compensating for these processing differences. Hence, simple, deductive, color treatments may have facilitated the performance of both field-independent and field-dependent groups in different ways.

4. The attributes of color-cueing may have a possible interrelated role in concept-attainment tasks in which performance is measured through the use of both line-drawings and realia. A comparison of the significant three-way interaction (color/non-color x inductive/deductive x simple/complex) for the line-drawings posttest in Figure 2 with the three-way interaction of the same variables for the realia posttest in Figure 3, will illustrate the potential of the interrelated role of color.
5. In concept-attainment tasks, media attributes can facilitate information transfer from two dimensional instructional materials to realia. For example, simple, inductive, non-color treatments facilitated performance for all subjects in treatments that were not color-cued in the realia posttest. This effect was not apparent in the line-drawings posttest scores. The difference in findings may be related to the unique processing demands of the realia posttest which required learners to transfer knowledge and to identify actual examples of the concept (realia) that were taught the line-drawings. Simple, inductive, non-color presentations may have freed learners to actually utilize cognitive restructuring skills and hypothesis testing strategies. These treatments may have facilitated transfer by actively involving each learner in processing concept information.

Ease of transfer to real objects may be facilitated by media attributes which function to:

- (a) free the learner to utilize restructuring skills and hypothesis testing strategies
- and/or
- (b) permit active processing involvement by the learner.
- (c) increase the salience of relevant cues by isolating relevant details and directing attention to relevant details. Attention may be directed by delineating figure-ground relationships and reducing the counteremphasizer effect of irrelevant details.
- (d) decrease abstraction time and effort

Concluding Comments

Supplantation approaches seek to match the components or variables that contribute to instructional effectiveness. These variables are represented by the learning task (or what is to be learned), the learner (or the person to whom instruction is directed) and the media attributes (or how the message will be communicated). Ineffective instruction fails to integrate these three components. In order to be responsive to learners' processing needs, instructional design needs to be sensitive to the complex interrelationships between variables which contribute to instructional effectiveness. By merging theory into practice, instructional designers may master the art of developing instructional materials that are truly aptitude sensitive.

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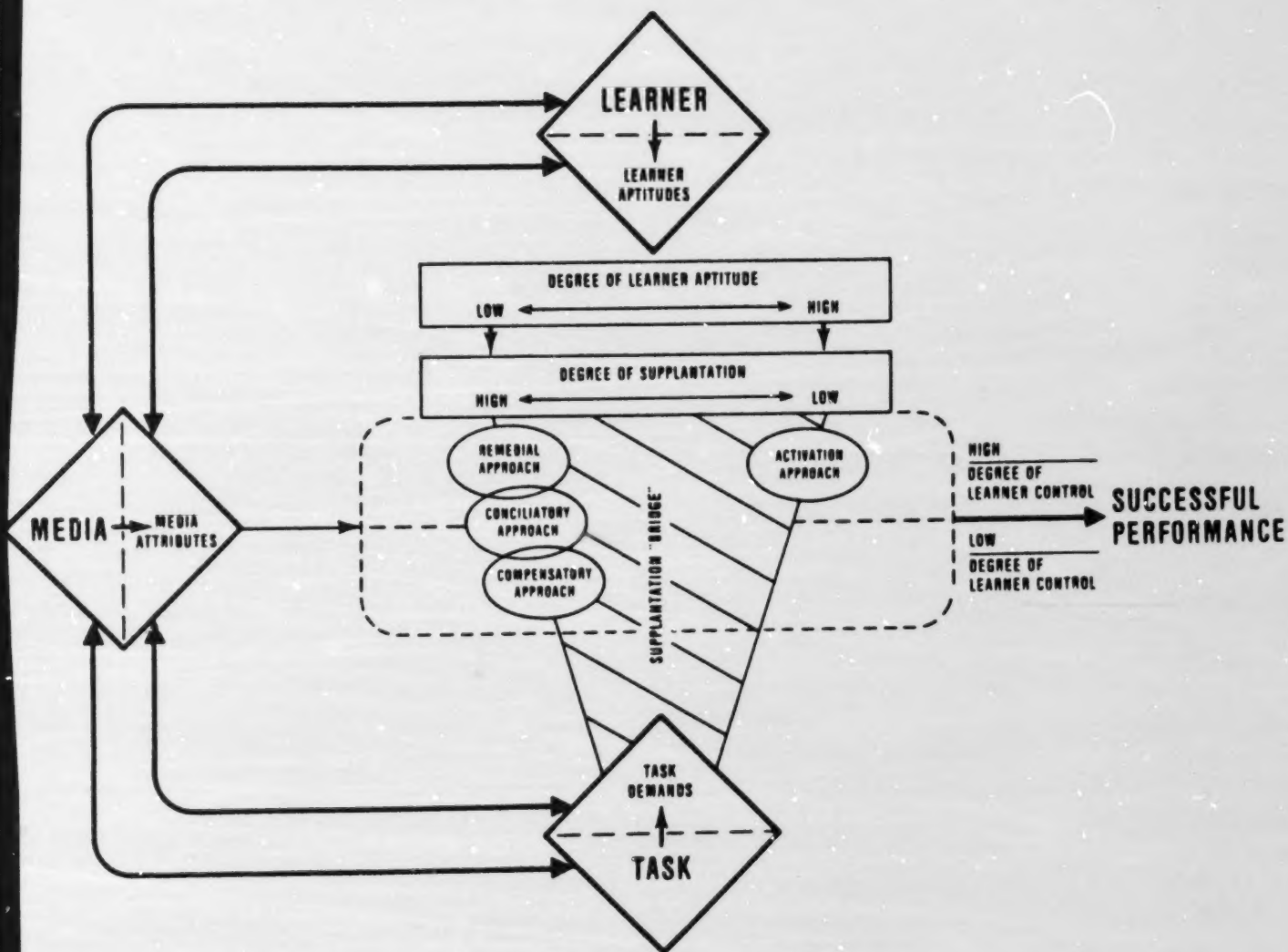


Figure 1: A Model for Aptitude Sensitive Instruction

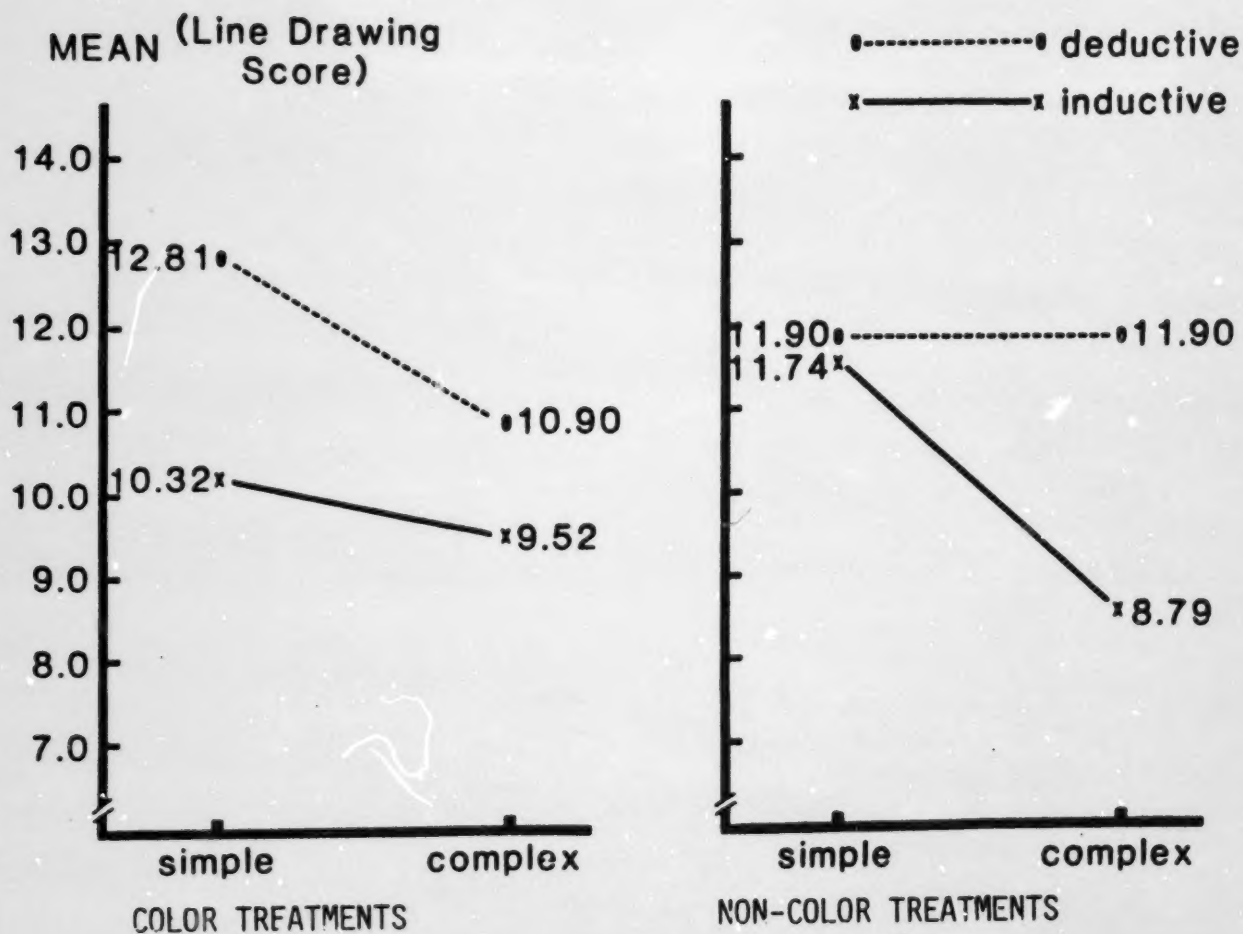


Figure 2: Graph of treatment means of the significant three-way interaction (color/non-color X simple/complex X inductive/deductive treatments)--line-drawing posttest

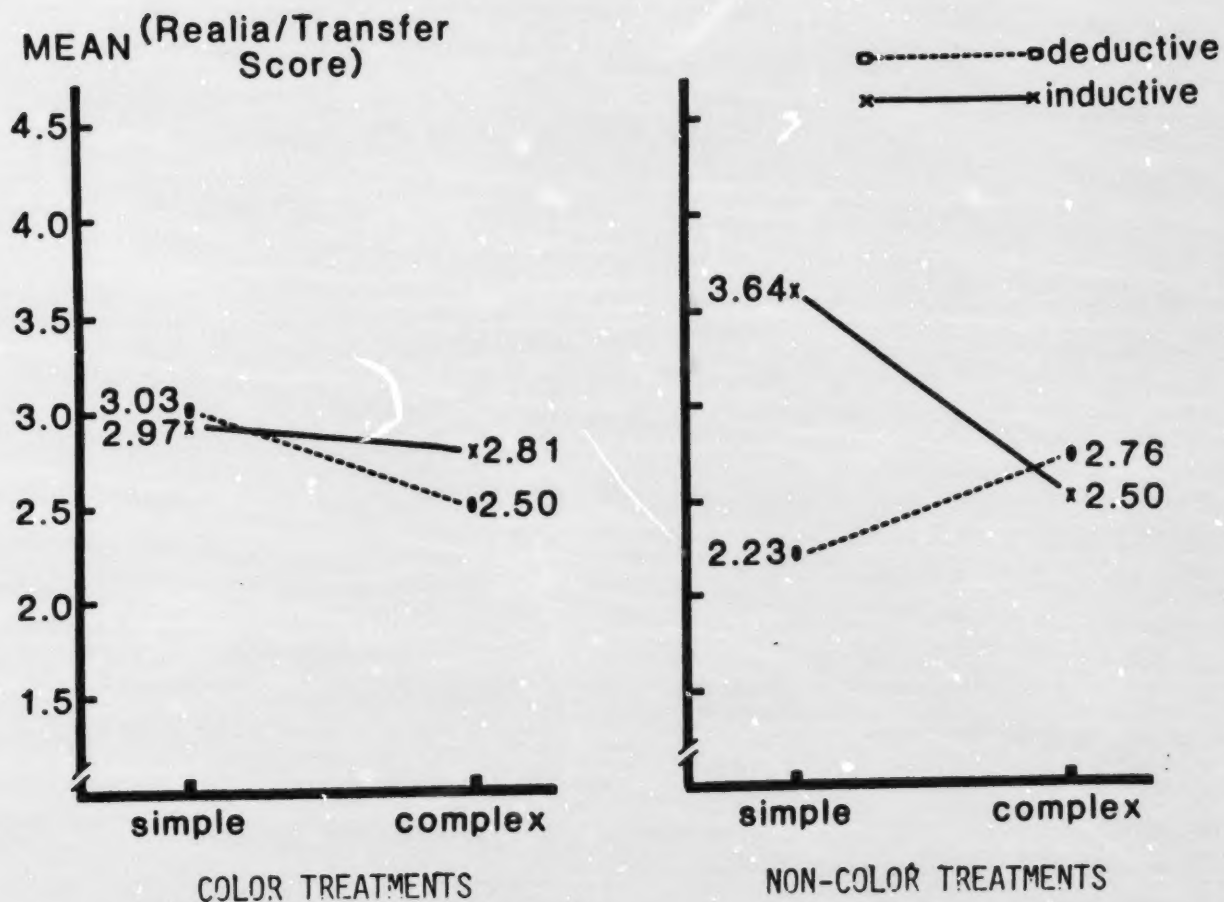


Figure 3: Graph of treatment means of the significant three-way interaction (color/non-color X simple/complex X inductive/deductive treatments)--Realia posttest

Table 1

Results of Hartley's Test of Homogeneity of
Variance for all Posttest Scores
(Kirk, 1968, p. 62)

Posttest	Largest Variance	Smallest Variance	df	$\frac{F}{\text{max.}}$
Line Drawings	23.98	7.27	16,13	3.30*
Realia	3.74	1.60	16,16	2.34*

* $p > .05$

Table 2

Analysis of Variance for Scores on Line Drawing
Posttest Items

Source of Variance	SS	df	MS	<u>F</u>
A Color/Non-Color Treatments	1.106	1	1.106	0.08
B Simple/Complex Treatments	141.401	1	141.401	10.45**
C Inductive/Deductive Treatments	161.716	1	161.716	11.95***
D Field-Dependent-Independent Aptitude	816.918	1	816.918	60.36****
AxB	0.017	1	0.017	0.00
AxC	6.591	1	6.591	0.49
AxD	0.884	1	0.884	0.07
BxC	27.057	1	27.057	2.00
BxD	85.416	1	85.416	6.31*
CxD	2.330	1	2.330	0.17
AxBxC	71.710	1	71.710	5.30*
AxBxD	3.945	1	3.945	0.29
AxCxD	42.299	1	42.299	3.13
BxCxD	10.584	1	10.584	0.78
AxBxCxD	10.117	1	10.117	0.75
Explained	1407.626	15	93.842	6.93
Residual	3099.174	229	13.534	-
TOTAL	4506.800	244	18.470	-

- * $p < .025$
 ** $p < .01$
 *** $p < .001$
 **** $p < .0001$

Table 3

Summary of Variance for Scores on the Line-Drawings Posttest Items, Including Tests for Simple Interaction Effects.

(Adapted from Keppel, 1973, pp.286-290, pp.325-327, pp.360-362; 1982, pp.304-309, pp.341-344; and Kirk, 1968, pp.222-224)

Source of Variance	SS	df	MS	F
A Color/Non-Color Treatments	1.106	1	1.106	0.08
B Simple/Complex Treatments	141.401	1	141.401	10.45***
C Inductive/Deductive Treatments	161.716	1	161.716	11.95***
BxC	27.057	1	27.057	1.99
BxC at a_1	9.347	1	9.347	0.69
BxC at a_2	66.023	1	66.023	4.87*
AxBxC	71.710	1	71.710	5.30**
Residual	3099.174	229	13.534	-
TOTAL	4506.800	244	18.470	-

* $p < .05$

** $p < .025$

*** $p < .001$

1. a_1 = color-cued

a_2 = non-color cued

Table 4

Summary of the Analysis of Variance on Line-Drawing Test Items, Including Tests for Simple, Simple Main Effects

(Adapted from Keppel, 1973, pp.290-292, pp.326-327, pp.360-362; 1982, pp.309-311; and Kirk, 1968, pp. 222-223)

Source of Variance ¹	SS	df	MS	F
A Color/Non-Color Treatments	1.106	1	1.106	0.08
B Simple/Complex Treatments	141.401	1	141.401	10.45****
C Inductive/Deductive Treatments	161.716	1	161.716	11.95****
AxB	0.017	1	0.017	0.00
AxC	6.591	1	6.591	0.49
BxC	27.057	1	27.051	2.09
B at a ₁ c ₁	9.710	1	9.710	0.72
B at a ₁ c ₂	55.354	1	55.354	4.09*
B at a ₂ c ₁	132.046	1	132.046	9.76***
B at a ₂ c ₂	-	1	-	- ^a
C at a ₁ b ₁	94.090	1	94.090	6.95***
C at a ₁ b ₂	28.896	1	28.896	2.14
C at a ₂ b ₁	0.388	1	0.388	0.03
C at a ₂ b ₂	146.758	1	146.758	10.84****
AxBxC	71.710	1	71.710	5.30**
Residual	3099.174	229	13.534	-
TOTAL	4506.800	244	18.470	-

* p < .05
** p < .025

*** p < .01
**** p < .001

a the mean scores for these cells were equal

1. a₁ = color-cued
a₂ = non-color cued
b₁ = simple line-drawing
b₂ = complex line-drawing
c₁ = inductive presentation
c₂ = deductive presentation

Table 5

Treatment Group Means and Standard Deviations for Field-Dependent and Field-Independent
Aptitude (Line-Drawing Posttest)

TREATMENTS	APTITUDE						ROW		
	Field-Dependent			Field-Independent			$\bar{X}$	(SD)	n
	$\bar{X}$	(SD)	n	$\bar{X}$	(SD)	n			
1. Simple, Inductive, Non-Color	10.00	(2.89)	19	13.93	(3.43)	15	11.74	(3.67)	34
2. Simple, Inductive, Color	7.27	(3.47)	15	13.85	(2.91)	13	10.32	(4.60)	28
3. Complex, Inductive, Non-Color	7.88	(3.04)	17	9.75	(3.45)	16	8.79	(3.33)	33
4. Complex, Inductive, Color	8.53	(3.78)	15	10.44	(4.35)	16	9.52	(4.13)	31
5. Simple, Deductive, Non-Color	8.54	(2.70)	13	14.47	(3.69)	17	11.90	(4.41)	30
6. Simple, Deductive, Color	11.06	(4.07)	16	14.67	(3.75)	15	12.81	(4.27)	31
7. Complex, Deductive, Non-Color	9.86	(4.90)	14	13.80	(3.63)	15	11.90	(4.66)	29
8. Complex, Deductive, Color	9.80	(4.34)	15	12.07	(3.83)	14	10.90	(4.19)	29
COLUMN	9.15	(3.78)	124	12.84	(3.99)	121	10.97	(4.30)	245

Table 6

Treatment Group Means and Standard Deviations for Aptitude x
Degree of Informative Detail x Type of Color-Cueing x Mode
of Presentation (Line-Drawing Posttest)

TREATMENTS	APTITUDE						ROW		
	Field-Dependent			Field-Independent			$\bar{X}$	(SD)	n
	$\bar{X}$	(SD)	n	$\bar{X}$	(SD)	n			
A. Degree of Informative Detail:									
(low) Simple	9.32	(3.56)	63	14.25	(3.42)	60	11.72	(4.27)	123
(high) Complex	8.97	(4.02)	61	11.45	(4.06)	61	10.21	(4.21)	122
B. Type of Color Cueing:									
Color-Cued	9.20	(4.13)	61	12.69	(4.02)	58	10.90	(4.42)	119
Non-Color-	9.10	(3.45)	63	12.96	(3.78)	63	11.04	(4.20)	126
C. Mode of Presentation:									
Inductive	8.50	(3.30)	66	11.87	(3.54)	60	10.10	(4.04)	126
Deductive	9.90	(4.00)	58	13.80	(3.73)	61	11.89	(4.38)	119
COLUMN	9.15	(3.78)	124	12.94	(3.99)	121	10.97	(4.30)	245

Table 7
Analysis of Variance of Scores on Realia Test Items

Source of Variance	SS	df	MS	F
A Color/Non-Color Treatments	0.180	1	0.180	0.07
B Simple/Complex Treatments	8.036	1	8.036	3.24
C Inductive/Deductive Treatments	8.322	1	8.322	3.36
D Field-Dependent-Independent Aptitude	18.210	1	18.210	7.35**
AxB	0.017	1	0.017	0.01
AxC	3.759	1	3.759	1.52
AxD	0.011	1	0.011	0.01
BxC	7.383	1	7.383	2.98
BxD	0.008	1	0.008	0.00
CxD	1.242	1	1.242	0.50
AxBxC	16.470	1	16.470	6.44*
AxBxD	0.046	1	0.046	0.02
AxCxD	5.608	1	5.608	2.26
BxCxD	0.928	1	0.928	0.38
AxBxCxD	4.298	1	4.298	1.73
Explained	73.435	15	4.896	1.98
Residual	572.622	231	2.479	--
TOTAL	646.057	246	2.626	--

* $p < .025$

** $p < .01$

Table 8

Summary of the Analysis of Variance for Scores
on Realia Posttest Items, Including Tests for
Simple Interaction Effects.

(Adapted from Keppel, 1973, pp.286-290,
pp.325-326, pp.360-362; 1982, pp.304-309,
pp.341-344; and Kirk, 1968, pp.222-224)

Source of Variance	SS	df	MS	<u>F</u>
A Color/Non-Color Treatments	0.081	1	0.081	0.07
B Simple/Complex Treatments	8.036	1	8.036	3.24
C Inductive/Deductive Treatments	8.322	1	8.322	3.36
BxC	7.383	1	7.383	2.98
BxC at a_1	1.046	1	1.046	0.42
BxC at a_2	21.378	1	21.378	8.62**
AxBxC	16.470	1	16.470	6.64*
Residual	572.622	231	2.479	-
TOTAL	646.057	246	2.626	-

* $p < .025$

** $p < .01$

Table 9

Summary of the Analysis of Variance for Scores
on Realia Posttest Items, Including Tests for
Simple, Simple Main Effects.
(Adapted from Keppel, 1973, pp.290-292,
pp.326-327, pp.360-362; 1982, pp.309-311;
and Kirk, 1968, pp.222-223)

Source of Variance	SS	df	MS	F
A Color/Non-Color Treatments	0.180	1	0.180	0.07
B Simple/Complex Treatments	8.036	1	8.036	3.24
C Inductive/Deductive Treatments	8.322	1	8.322	3.36
AxB	0.017	1	0.017	0.01
AxC	3.759	1	3.759	1.52
BxC	7.383	1	7.383	2.98
B at $a_1 c_1$	0.393	1	0.393	0.16
B at $a_1 c_2$	4.307	1	4.307	1.74
B at $a_2 c_1$	19.927	1	19.927	8.04**
B at $a_2 c_2$	8.491	1	8.491	3.43
C at $a_1 b_1$	0.055	1	0.055	0.02
C at $a_1 b_2$	1.475	1	1.475	0.59
C at $a_2 b_1$	30.484	1	30.484	12.30***
C at $a_2 b_2$	1.037	1	1.037	0.42
AxBxC	16.470	1	16.470	6.64*
Residual	572.622	231	2.479	-
TOTAL	646.057	246	2.626	-

* $p < .025$ ** $p < .01$ *** $p < .001$

Table 10

Treatment Group Means and Standard Deviations for Field-Dependent and Field-Independent
Aptitude (Realia Posttest)

TREATMENTS	APTITUDE						ROW		
	Field-Dependent			Field-Independent			$\bar{X}$	(SD)	n
	$\bar{X}$	(SD)	n	$\bar{X}$	(SD)	n			
1. Simple, Inductive, Non-Color	3.61	(1.75)	18	3.66	(1.40)	15	3.64	(1.58)	33
2. Simple, Inductive, Color	2.40	(1.40)	15	3.57	(1.60)	14	2.97	(1.59)	29
3. Complex, Inductive, Non-Color	2.35	(1.93)	17	2.65	(1.50)	17	2.50	(1.71)	34
4. Complex, Inductive, Color	2.67	(1.35)	15	2.94	(1.44)	16	2.81	(1.38)	31
5. Simple, Deductive, Non-Color	1.54	(1.27)	13	2.76	(1.86)	17	2.23	(1.72)	30
6. Simple, Deductive, Color	3.00	(1.26)	16	3.07	(1.07)	15	3.03	(1.45)	31
7. Complex, Deductive, Non-Color	2.29	(1.54)	14	3.20	(1.61)	15	2.76	(1.62)	29
8. Complex, Deductive, Color	2.13	(1.36)	15	2.87	(1.88)	15	2.50	(1.66)	30
COLUMN	2.54	(1.59)	123	3.07	(1.62)	124	2.81	(1.62)	247

Table 11

Treatment Group Means and Standard Deviations for Aptitude x
Degree of Informative Detail x Type of Color Cueing x Mode
of Presentation (Realia Posttest)

TREATMENTS	APTITUDE						ROW		
	Field-Dependent			Field-Independent			$\bar{X}$	(SD)	n
	$\bar{X}$	(SD)	n	$\bar{X}$	(SD)	n			
A. Degree of Informative Detail:									
(low) Simple	2.73	(1.61)	62	3.24	(1.65)	61	2.98	(1.64)	123
(high) Complex	2.36	(1.54)	61	2.90	(1.58)	63	2.64	(1.58)	124
B. Type of Color Cueing:									
Color-Cued	2.56	(1.35)	61	3.10	(1.63)	60	2.83	(1.61)	121
Non-Color	2.53	(1.80)	62	3.05	(1.62)	64	2.79	(1.72)	126
C. Mode of Presentation:									
Inductive	2.78	(1.61)	65	3.18	(1.48)	62	2.98	(1.61)	127
Deductive	2.28	(1.37)	58	2.97	(1.75)	62	2.63	(1.62)	120
COLUMN	2.54	(1.59)	123	3.07	(1.62)	124	2.81	(1.62)	247